HOW IS VALUE CREATED IN SPIN-OFFS? A LOOK INSIDE THE BLACK BOX

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Abstract

Using a unique sample of plant level data from the Longitudinal Research Database (LRD), we identify (for the first time in the literature), *how* (the precise channel and mechanism), *where* (parent or subsidiary), and *when* (the dynamic pattern) performance improvements arise following corporate spin-offs. We identify the source of value improvements in spin-offs by comparing the magnitude of post-spin-off changes in the wages, employment, materials costs, rental and administrative expenses, sales, and capital expenditures in the plants belonging to firms undergoing spin-offs relative to the magnitude of such changes in a control group of plants belonging to firms not undergoing spin-offs. We show that the total factor productivity (TFP) of plants belonging to spin-off firms (parent or spun-off subsidiary) increase, on average, following the spin-off. This increase in overall productivity begins immediately, starting with the first year following the spin-off, and continuing in the years thereafter. This performance improvement can be attributed to a decrease in workers' wages, employment at the plant, decrease in the cost of materials purchased, as well as a decrease in rental and office expenditures, but not from improved product market performance by these plants. Further, such productivity improvements arise primarily in plants that remain with the parent; plants belonging to the spun-off subsidiary do not experience such productivity increases. However, contrary to speculation in the previous literature, plants that are spun-off *do not* underperform parent plants prior to the spin-off. Finally, in our split-sample study of plants that were acquired subsequent to the spin-off and those that were not, we find that productivity increases for both groups of plants: while such productivity increases start immediately after the spin-off for the non-acquired plants, for the acquired plants they occur only after being taken over by a better management team.

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1 Introduction

Several recent papers have documented a significant improvement in the accounting performance of firms following corporate spin-offs (see, e.g., Daley, Mehrotra, and Sivakumar (1997), and Desai and Jain (1999)), and a corresponding increase in the combined stock market value of firms following spin-offs (see, e.g., Cusatis, Miles and Woolridge (1993)).[1] However, little is known about *how* such performance and value improvements are generated following spin-offs. Thus, the precise source of such post-spin-off performance and value gains and the mechanism leading to the generation of such gains have not been established. Do these performance improvements arise from better aggregate product market performance (sales) by the two entities (parent firm and spun-off entity) compared to the pre-spin-off (joint) firm? Or, do they arise from savings in various costs by the two entities resulting from the spin-off relative to the pre-spin-off joint firm? For example, do such value improvements arise from reducing the aggregate level of employment in these post-spin-off entities relative to the joint firm, or by reducing the average wage per employee (or both), thus reducing total labor costs? Or do they arise from the management of these post-spin-off entities reducing materials and other input costs by engaging in more aggressive negotiations with suppliers or using such inputs more efficiently? Alternatively, do they arise from reductions in rental and administrative expenses by these entities? Finally, do they arise from the firm increasing investments in more productive capital expenditures or cutting down on unproductive capital expenditures? The first objective of this paper is to use plant level data from the Longitudinal Research Database (LRD) of the U.S. Census Bureau to identify the precise source of value creation in spin-offs by studying how spin-offs lead to changes in the above variables (in the plants belonging to firms undergoing such restructuring).

The second (and related) objective of this paper is to identify some of the mechanisms through which spin-offs generate value. A number of theoretical rationales for the performance and value improvements in firms

[1] A corporate spin-off occurs when a firm creates a subsidiary to hold a portion of its assets, and then distributes the shares of the subsidiary on a pro-rata basis to its existing shareholders to create an independent company. Thus no new capital is raised by the joint firm in spin-offs. In contrast, in equity carve-outs, the firm issues new shares against a portion of the firm, thus raising external financing, while simultaneously creating a new company (the parent firm may also continue to hold a substantial fraction of the equity in the new firm after the carve-out). In this paper, we will study only corporate spin-offs.

following spin-offs have been proposed in the literature. In a recent theoretical paper, Chemmanur and Yan (2004) argue that such improvements arise from the disciplining effects of spin-offs on firm management.[2] In their setting, incumbent firm management not only enjoy security benefits like all other shareholders (arising from any increases in the equity value of the firm) but also enjoy private benefits from control, which are lost in the event of a takeover by another management team. Thus, spin-offs discipline management in their setting by increasing the probability of a takeover by a rival management team subsequent to the spin-off. There are two possible ways through which this can result in performance improvements: First, since spin-offs increase the probability of loss of control for current management through a takeover, they motivate current management to work harder, leading to an increase in operating performance even in the absence of an actual takeover subsequent to the spin-off ("the pure disciplining effect"). Second, if a takeover in fact occurs after the spin-off, there may be an additional improvement in firm performance, due to the better ability of the new management team ("the change of control effect"). While the objective of this paper is neither to test the Chemmanur and Yan (2004) model, nor to run a "horse race" between theories of spin-offs, we split our sample of plants belonging to firms undergoing spin-offs into those that were acquired within five years after the spin-off, and those that were not acquired. We then compare the value improvements occurring in the two groups of plants, thus disentangling the value improvements arising from a pure disciplining effect of spin-offs from those arising from a change of control effect. This allows us to identify some of the mechanisms through which spin-offs generate performance and value improvements.[3]

The third objective of this paper is to identify *where* the performance improvements in spin-offs occur: Do these value improvements occur predominantly in parent plants (plants continuing with the parent firm, which is usually the larger entity) or predominantly in the plants belonging to the spun-off entity or "subsidiary"

[2] It seems natural to think that a more disciplined firm management has an incentive to cut labor and other costs compared to one that is less disciplined. For example, if labor is unionized within the firm, managers might submit to higher wages in order to reduce their cost of putting forth effort in bargaining with labor. Further, paying workers higher than competitive wages may reduce worker complaints and ensure a harmonious work place environment, thus reducing the effort required to manage the firm. Thus, one would expect the increased discipline imposed on firm management following spin-offs to have a significant negative impact on wages and employment in the firm. For similar reasons, one would also expect more disciplined management to devote greater efforts toward negotiating better prices and using materials more efficiently, leading to a decrease in materials costs following spin-offs. Similar motivations can result in reductions in rental and administrative expenses and other costs following spin-offs.

[3] It is important to emphasize that it is not our objective to distinguish between various theories of spin-offs. Thus, our results may also be consistent, to some degree, with other theories of spin-offs predicting improvements in operating performance following spin-offs. For example, Aaron (1991) argues that spin-offs enable the firm to provide better incentives for firm management based on the stock price of the individual entities. However, since such theories do not have implications for the timing and magnitude of value improvements in plants belonging to firms where either the parent or the spun-off entity were subsequently taken over versus those which were not, we use the Chemmanur and Yan (2004) model to generate some of the hypotheses for our empirical work.

(usually the smaller of the two entities), or do such value improvements occur substantially in both entities? This question is particularly relevant in the context of speculation by prior firm-level empirical studies (see, e.g., Desai and Jain (1999)) that firms spin-off their underperforming divisions. This speculation has been based on the fact that, subsequent to the spin-off, the spun-off entity underperforms the parent (recall that firm-level studies are unable to observe the performance of the spun-off entity *prior* to the spin-off). In contrast to firm-level studies, we are able to study the performance of plants belonging to both parents and spun-off subsidiaries *before and after* the spin-off. This allows to not only identify whether the value improvements from spin-offs arise predominantly in parent plants or in subsidiary plants (or in both), but also allows us to compare the performance of parent and subsidiary plants prior to the spin-off, and thus verify whether firms indeed spin off their underperforming divisions.

The fourth and final objective of this paper is to study *when* performance improvements occur following spin-offs: i.e., the dynamic pattern of performance improvements around the spin-off. Thus, we split-up the overall improvements in firm performance subsequent to spin-offs into performance changes occurring in the year of the spin-off, and after one, two, and three (or more) years after the spin-off. Moreover, in order to link these overall improvements in performance to the different channels through which they may arise, we also study the dynamic pattern of changes in the various product and labor market variables discussed above following spin-offs.

We start by investigating whether, consistent with the existing literature documenting improvements in accounting performance following spin-offs; spin-offs indeed lead to an increase in the overall efficiency of the plants involved in spin-offs. Similar to papers that have used plant level data to study other corporate events (see, e.g., Schoar (2002), and Maksimovic and Phillips (2001)), we use total factor productivity (TFP) as our measure of overall plant efficiency. We then compare the magnitude of changes subsequent to spin-offs in the wages, employment, materials costs, rental and administrative expenses, sales, and capital expenditures in the plants belonging to firms that have undergone such restructuring relative to the magnitude of such changes in a control group of plants that have not undergone this restructuring. We find that there is an improvement in the overall efficiency (as measured by the TFP) of plants belonging to firms involved in spin-offs (averaging across all plants, regardless of whether they belonged to the parent or spun-off subsidiary). This increase in overall productivity begins immediately, starting with the first year following the spin-off, and continues for four years thereafter. Further, this increase in productivity arises from multiple sources: it arises from decreases in employment and total wages, and from decreases in materials costs, and in rental and administrative expenses. However, it does not come from increases in product market performance (sales), or from changes in the level of new capital expenditure in these plants subsequent to spin-offs.

We show that the improvement in the average productivity of plants following spin-offs is driven primarily by improvements in the productivity of plants continuing with the parent firm, and not from productivity improvements in plants belonging to the spun-off entity. However, contrary to the speculation in the existing literature, we document that plants that are spun-off do *not* perform worse than those belonging to the parent *prior* to the spin-off: in fact, plants in the spun-off entity perform better than the parent plants prior to the spin-off.

Consistent with the disciplining effect of spin-offs, we find that the probability of a takeover increases after the spin-off. In our split-sample analysis of subsequently acquired versus non-acquired plants, both a pure disciplining effect and a change of control effect are documented, i.e., efficiency increases in non-acquired plants also. The sub-sample of plants which are not acquired after the spin-off exhibits a pure disciplining effect: productivity improvements start immediately after the spin-off, and this improvement is seen to arise due to immediate decreases in labor and other costs. In contrast, such improvements in productivity arise primarily from a change of control effect in the sub-sample of plants that were acquired subsequent to the spin-off. A pure disciplining effect is not documented in these latter plants (in other words, there is no improvement in productivity in this sub-sample of plants prior to acquisition by another firm). This is consistent with the notion that firms undergoing spin-offs which do not exhibit a pure disciplining effect starting immediately following the spin-off becoming takeover targets, with an increase in efficiency occurring after they are acquired by another firm. Finally, in our split-sample analysis of "related" versus "unrelated" spin-offs, the overall gain in efficiency (in terms of TFP changes) is similar for related and unrelated spin-offs, though the disciplining effect in terms of the labor market variables is stronger for unrelated spin-offs.

This paper is related to the large empirical literature on spin-offs and tangentially related to the smaller theoretical literature on spin-offs.[4] Much of the empirical spin-off literature (e.g., Hite and Owers (1983), Schipper and Smith (1983), and Miles and Rosenfeld (1983)) has concentrated on documenting positive abnormal stock returns (ranging from 2.4 to 4.3 percent) to spin-off announcements, which is, however, not the focus of this paper.[5] More recently, Cusatis, Miles, and Woolridge (1993) document that both subsidiaries and parents experience significantly more takeovers following spin-offs than do control firms not undergoing spin-offs. Further, while they also document positive abnormal returns to spin-off announcements, they show that these positive abnormal returns arise primarily from the sub-sample of firms that are acquired within a certain period of time subsequent to the spin-off. However, they do not study the real effects (performance improvements) of spin-offs. More closely related to this paper are the firm-level empirical studies (e.g., Daley, Mehrotra, and Sivakumar (1997), Desai and Jain (1999)) that document improvements in accounting performance following spin-offs. These studies, however, do not empirically address the source of these operating performance improvements or the mechanism driving these improvements. Further, given their firm-level nature, such studies are also unable to analyze the location (parent versus subsidiary) of such performance improvements.[6]

While there have been no plant level studies of corporate spin-offs in the literature, two plant-level studies of related corporate phenomena deserve mention here. The first paper is Schoar (2002), who studies the effect of corporate diversification on the productivity of the plants involved. Schoar (2002) documents a decline in the overall TFP of plants belonging to diversifying firms. This result can be thought as the mirror image of our results documenting that spin-offs improve productivity (to the extent that spin-offs can be thought of as the opposite of corporate diversification). Maksimovic and Phillips (2001), study the impact of partial firm asset sales on the productivity of the plants involved. They find that, when firms purchase plants of lower

[4] In addition to Chemmanur and Yan (2004) and Aaron (1991), two other theoretical models of spin-offs are Habib, Johnsen, and Naik (1997) and Nanda and Narayanan (1999). The two latter theoretical models, however, focus on how spin-offs lead to increases in the stock market value of the combined firm rather than on explaining improvements in operating performance following spin-offs. Thus Habib, Johnsen, and Naik (1997) argue that spin-offs improve the quality of the information managers and uninformed investors can infer from the prices of the firm's traded securities, leading to an increase in the stock market value of the two entities arising from spin-offs. Nanda and Narayanan (1999) suggest that firms may engage in spin-offs in order to be correctly valued by the capital markets which would allow them to raise capital at a fair market price after the divestiture.

[5] In the process of documenting this abnormal positive stock price reaction to spin-off announcements, these papers have also offered various rationales for the stock price improvements following spin-offs. For example, Miles and Rosenfeld (1983) argue that the increase in stockholder wealth may come about due to the elimination of negative synergies between divisions, or due to the increased flexibility that investors get after the spin-off. On the other hand, Schipper and Smith (1983) argue that the gains associated with spin-offs arise from relaxed regulatory and tax constraints and improved managerial efficiency.

[6] There are several other empirical papers on corporate spin-offs. With regard to capital structure decision and allocation of debt following spin-offs, see Dittmar (2004) and Parrino (1997). McConnell, Ozbilgin, and Wahal (2001) test if an ex ante trading strategy based on Cusatis, Miles and Woolridge (1993) earns excess returns. Krishnaswami and Subramanium (1999) analyze the information hypothesis of corporate spin-offs.

productivity, existing plants increase in productivity but the acquired plants decline in productivity.

The rest of this paper is organized as follows. Section 2 describes the data and explains the construction of the different variables used in this study. Section 3 describes our empirical methodology and presents the results of our empirical tests. Section 4 concludes.

2 Data, Sample Selection, and Construction of Variables

We use data from the Longitudinal Research Database (LRD), maintained by the Center of Economic Studies at the U.S. Bureau of Census.[7] The LRD is a large micro database which provides plant level information for firms in the manufacturing sector (SIC codes 2,000 to 3,999). The LRD tracks approximately 50,000 manufacturing plants every year in the Annual Survey of Manufacturers (ASM), which covers all plants with more than 250 employees. In addition, it also includes smaller plants that are randomly selected every fifth year to complete a rotating five year panel. Most of the data items reported in the LRD (e.g., the number of employees, employee compensation, and total value of shipments) represent items that are also reported to the IRS, increasing the accuracy of the data.

There are three advantages of using the LRD data relative to COMPUSTAT data in the study. First, coverage is at the plant level which allows us to identify the performance of individual plants, and hence the performance of the parent and subsidiary units separately, both before and after a spin-off. Second, the nature of this data allows us to identify the precise channels of efficiency changes at the plant level. Third, it covers both public and private firms in the manufacturing industries, enabling us to identify even those plants which were subsequently acquired by private firms after the spin-off. In this study, we use data from the LRD for the period 1975 through 2000. We identify the ownership changes of plants using the Ownership Change Database (OCD).[8] The OCD allows us to track plants even as they change owners; among several other things it correctly identifies acquisitions of plants.[9]

Our sample of spin-offs is drawn from Security Data Corporation's (SDC) *Mergers and Acquisitions Database* and the daily return files of the Center for Research in Security Prices (CRSP), which identifies spin-offs as firms

[7] See McGuckin and Pascoe (1988) who provide a detailed description of the Longitudinal Research Database (LRD) and the method of data collection.

[8] For a detailed description of the OCD see Nguyen (1998).

[9] It is more precise than simply using the CC and SC codes from the LRD to identify plant acquisitions.

with dividend distribution codes of 3763, 3764, and 3765.[10] The subsidiaries divested in the spin-off transactions were identified and cross-checked with reports appearing in news wires and articles in *Lexis-Nexis* and the *Wall Street Journal*. We also excluded from our sample non-voluntary spin-offs such as those forced through antirust regulations, and limit the sample to only tax-free spin-offs, as identified by the *CCH Capital Change Reports*.[11] As such, non-taxable spin-offs represent restructuring in which a parent firm effectively removes itself from the management and ownership of the subsidiary. These pure spin-offs represent the restructuring studied here. We also removed from our sample those spin-offs in which one firm engaged in multiple spin-offs within a five-year window of the ex-dividend year. Thus our final sample of spin-offs comprise 132 firms during the years 1980 to 2000 belonging to the manufacturing sector (SIC codes 2,000 to 3,999). We match this sample of firms to the LRD using an LRD-COMPUSTAT bridge file.

2.1 Productivity Measures

The primary measure of plant performance used in this paper is Total Factor Productivity (TFP) at the annual four-digit industry level. We obtain measures of TFP at the plant level, by estimating a log-linear Cobb-Douglas production function for each industry and year. Industry is defined at the level of four-digit SIC codes.[12] Individual plants are indexed i; industries j; for each year t, in the sample:

$$\ln(Y_{ijt}) = \alpha_{jt} + \beta_{jt}\ln(K_{ijt}) + \gamma_{jt}\ln(L_{ijt}) + \delta_{jt}\ln(M_{ijt}) + \varepsilon_{ijt} \quad (1)$$

This is more flexible than the cash-flow measure of performance, as it does not impose the restriction of constant returns to scale and constant elasticity of scale. Also, since coefficients on capital, labor, and material inputs can vary by industry and year, this specification allows for different factor intensities in different industries. These production function estimates are pooled across the entire universe of manufacturing plants,

[10] The stock distributions that CRSP identifies as spin-offs sometimes include new issues of another class of shares by a firm. Also, SDC sometimes reports equity carve-outs and distributions of common stock in other publicly traded firms that are not subsidiaries of the firm as spin-offs. In order to eliminate such discrepancies from our sample, we obtained additional information regarding the spin-offs from news wires and articles on *Lexis-Nexis* and the *Wall Street Journal*.

[11] According to section 335 of the Internal Revenue Code, to be eligible for tax-exempt status, (1) a parent firm must distribute at least 80% of the outstanding shares of a subsidiary to its existing shareholders and any shares retained by the parent firm must not constitute practical control of the subsidiary; (2) both the parent and subsidiary must be engaged in an active trade or business for at least five years before the distribution date; and (3) the transaction may not be used as a means for distributing profits and must be done for a sound business reason.

[12] As a robustness check, we re-estimate the production function using two and three digit SIC industry classifications. We also estimate TFP with value added production function specifications and separate white and blue collar labor inputs. In all cases we find equivalent results.

whether they were involved in a spin-off or not. The TFP measure for each individual plant is the estimated residual of these regressions. Thus it is the difference between the actual output produced by the plant compared to its "predicted output". This "predicted output" is what the plant should have produced, given the amount of inputs it used and the industry production technology in place. Hence a plant that produces more than the predicted amount of output in any given year has a greater than average productivity for that year. Thus, TFP can be understood as the relative productivity rank of a plant within its industry in any given year. Since these regressions include a constant term, TFP only contains the idiosyncratic part of plant productivity.[13] TFP measures are windsorized at the 1st and 99th percentile.

We use the LRD data to construct as closely as possible the variables in the production function. Output (Y) is constructed as plant sales (total value of shipments in the LRD) plus changes in the value of inventories for finished goods and work-in-progress. Under perfect competition, all plants in an industry will receive the same price for their output and our measure will be proportional to the actual quantity of output. However, if product markets are imperfectly competitive, the residuals will reflect both variations in efficiency as well as variations in price. We do not find any evidence that spin-offs are more likely to happen when a part of the firm operates in a concentrated industry given that our spin-off plants are equally dispersed throughout the entire manufacturing sector. Thus, we believe that the dispersion of TFP for our spin-off plants almost entirely reflects dispersions in efficiency.

Labor input (L) is defined as production worker equivalent man hours, that is, the product of production worker man-hours, and the ratio of total wages and salaries to production worker wages. We also re-estimate the TFP regression specifying labor input to include non-production workers. Results remain qualitatively the same. Values for the capital stock (K) are generated by the recursive perpetual inventory formula. We use the earliest available book value of capital as the initial value of net stock of plant capital (this is either the value in 1972, or the first year a plant appears in the LRD sample). These values are written forward annually with nominal capital expenditure (appropriately deflated at the industry level) and depreciated by the economic depreciation rate at the industry level obtained from the Bureau of Economic Analysis. Since values of all these

[13] As a robustness check for our regression results we use an alternative measure of productivity; valued added per worker, which is defined as total sales less materials cost of goods sold, divided by the number of workers. This measure has been used in McGuckin and Nguyen (1995) and Maksimovic and Phillips (2001). This measure does not have the desirable theoretical properties of TFP, but does have familiar statistical properties, since it is not computed from a regression.

variables are available separately for buildings and machinery, we perform this procedure separately for each category of assets. The resulting series are then added together to yield our capital stock measure. Finally, material input (M) is defined as expenses for the cost of materials and parts purchased, resales, contract work, and fuel and energy purchased, adjusted for the change in the value of material inventories. All the variables are deflated using annual price deflators for output, materials, and investment at the four-digit SIC level from the Bartelsman and Gray NBER Productivity Database.[14] Deflators for capital stock are available from the Bureau of Economic Analysis.[15]

2.2 Other Measures

TFP provides us with a measure of the overall efficiency of the plant. However, we are also interested in knowing the different channels through which this overall value creation arises. We consider labor market variables, materials, rental costs and administrative expenses, product market performance, and investments in new projects as the possible channels through which this value creation may take place. To analyze if the channel of value creation is through the labor market we look at total employment, measured by the log of total number of production and non-production workers at the plant annually, and total salaries and wages measured by the log of total production and non-production worker wages including fringe benefits such as legally required, and voluntary supplementary labor costs. Rental and administrative costs are measured by the log of rental payments or equivalent charges made during the year for the use of buildings, structures, and various office equipments. Materials cost, sales, and new capital expenditures are also measured in log terms and defined in the previous sub-section. All variables are windsorized at the 1st and 99th percentile.

3 How do Spin-offs Increase Efficiency?

3.1 Descriptive Statistics and Univariate Results

The sample used in this study comprises all plants that were involved in a spin-off between the years 1980 and 2000. In order to benchmark the effect of spin-offs on plants, we also include in our sample those plants

[14] See Bartelsman and Gray (1996) for details.

[15] For a detailed description of the construction of TFP measures from LRD variables see Lichtenberg (1992).

belonging to conglomerate firms that were not involved in a spin-off.[16] Since part of our study analyses the effect on plants even before the spin-off, our sample contains observations on all these plants from 1975 to 2000. On average firms which are involved in a spin-off are bigger than non-spin-off firms; non-spin-off firms on average have 30 plants, while spin-off plants have 55; average plant sales for non-spin-off plants is \$33.5 million, while for spin-off plants it is about 40% higher (\$47.7 million).

The univariate results of Table 1 document the overall efficiency of plants before and after the spin-off. It also shows the channels through which the increase in efficiency occurred. On average, total factor productivity increased by about 50%. Primarily this increase in efficiency occurred due to drastic reductions in total wage, total employment, and materials costs at the plants. However, this increase in efficiency did not arise due to better product market performance or increase in new capital expenditures by these plants after the spin-off.[17]

3.2 Effect of Spin-off on a Plant

3.2.1 The Average Effect across all Plants

We first consider the average effect of a spin-off on the overall efficiency of a plant and identify the channels through which this efficiency arises. We use total factor productivity (TFP) as a comprehensive index of efficiency. To analyze the impact of a spin-off on plants that were involved in one, vis-à-vis those that were not, we employ a regression framework which has certain advantages. First, we can include plant fixed effects which allows us to precisely control for any cross-sectional differences between plants. Second, as the spin-offs are distributed over time, by defining an "after spin-off " dummy we can easily allow for the staggering of the event. Finally, we can control for time varying observables of the plant. We implement this approach through the following regression:

$$Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta SpinAft_{it} + \varepsilon_{it} \tag{2}$$

where Y_{it} is the variable of interest, (e.g., TFP, log of total wages etc.), X_{it} is a control for plant size which is time varying, $SpinAft_{it}$ is a dummy variable, which equals 1 if the plant is involved in a spin-off and the

[16] We retain all plants in our sample which belong to multi-unit firms; i.e. any non-spin-off firm in our sample has at least two plants. We eliminate all single-unit firms from the LRD as it is impossible for them to be involved in a spin-off. Thus, hypothetically all plants in our sample have a positive probability of being involved in a spin-off.

[17] Due to the disclosure rules of the Census Bureau, we cannot show medians or quartile ranges.

observation is in a year after the spin-off, and 0 if it is a non-spin-off plant or a spin-off plant with the observation belonging to a year prior to the spin-off.[18] i indexes plants, t indexes years, and β_i are plant fixed effects. The specification also incorporates year dummies.[19] The above specification is estimated on panel data of both spin-off and non-spin-off plants.

Our estimate of the effect of a spin-off on the plant is δ, the coefficient on $SpinAft$. Table 2 presents the results which show the average effect of the spin-off on any plant involved in the spin-off, be it with the parent or with the subsidiary. The column headings are the dependent variables in the different specifications. As can be seen from the table, TFP increases after the spin-off with the coefficient on the dummy being significant at the 1% level. This increase in TFP primarily arises due to decreases in employment, total wages and materials cost at the plant. All the coefficients on the dummy in these regressions are significant at the 1% level. Product market performance of the plant (sales) and new capital expenditures do not increase after the spin-off, thus indicating that the increase in efficiency subsequent to the spin-off does not come from higher sales or new investments in positive NPV projects. The overall increase in efficiency primarily comes from downsizing labor and from negotiating better terms with suppliers. Moreover, this increase in TFP of 1.3% is also economically significant, as it translates to an increase in profits of approximately 8% annually.[20]

Consistent with the disciplining effect of spin-offs, the evidence presented in Table 2 suggests that the primary channel due to which efficiency increases is through a decrease in workers' wages. The coefficient of the $SpinAft$ dummy in the total wage regression suggests that wages go down by about 2.5% following spin-offs. Given that the mean total wage in a spin-off plant in our sample is $7.434 million, and that on average a firm which engaged in a spin-off has about 55 plants, a decrease of 2.5% in total wage translates to a decrease of approximately $10.2 million annually for an average firm involved in a spin-off.[21] Moreover, also consistent with the disciplining effect, we find that a spin-off leads to a decrease in materials cost at the plant.

[18] This variable is conceptually similar to the interaction of two dummy variables $Spin * After$ where $Spin$ is a dummy variable which equals 1 if the plant is involved in a spin-off and 0 otherwise, and $After$ is a dummy variable which equals 1 if the observation is in a year following the spin-off and 0 otherwise. Note that $After$ is always 0 for a non-spin-off firm. Thus, this specification implicitly takes all plants that have not been involved in a spin-off prior to time t as the control group.

[19] In results not reported here, we also estimate the specification by including industry dummies. The results remain qualitatively the same.

[20] For a detailed explanation of the relation between TFP and profits see Schoar (2002). The 8% annual increase in profits is based on the assumption of a revenue margin of 20% over costs.

[21] Our results are also consistent with those presented in Schoar (2002) where she suggests that workers in diversified firms earn rents.

3.2.2 The Effect of Spin-off on Parent and Subsidiary Plants

Above we presented the results of the average effect of spin-off on any plant which was involved in the spin-off. We now differentiate the plants based on the entity to which they belong; the parent, i.e., the continuing entity, or the subsidiary i.e., the spun-off entity. To capture the effects of the spin-off we estimate the following modified version of the same regression framework.

$$Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_1 ParAft_{it} + \delta_2 SubAft_{it} + \varepsilon_{it} \quad (3)$$

Again, Y_{it} is the variable of interest, (e.g., TFP, log of total wages etc.), and X_{it} is a control for plant size which is time varying. In (3) $ParAft_{it}$ is a dummy variable, which equals 1 if it is a parent plant and the observation is in a year after the spin-off, and 0 if it is a non-spin-off plant or a parent plant with the observation belonging to a year prior to the spin-off. Similarly, $SubAft_{it}$ is a dummy variable, which equals 1 if it is a subsidiary plant and the observation is in a year after the spin-off, and 0 if it is a non-spin-off plant or a subsidiary plant with the observation belonging to a year prior to the spin-off. The regression is estimated with plant fixed effects and year dummies. The results are presented in Table 3.

The coefficients of interest here are δ_1 and δ_2.It can be seen clearly from Table 3 that the entire increase in efficiency comes from plants in the parent unit, where the coefficient on the dummy in the TFP regression is significant at the 1% level. Again, the main channels through which efficiency increases in the parent plants are decreases in total employment, total wage, (both are significant at the 1% level) and rental and administrative expenses (significant at the 5% level). Product market performance and investment in new projects do not change subsequent to the spin-off for the parent plants. For the subsidiary plants even though the coefficient on the dummy is positive in the TFP regression, it is insignificant, indicating that there is no overall increase in efficiency. There is a decrease in costs in the subsidiary plants after the spin-off, due to a decrease in the total wage bill and also in materials costs. However, for these plants rental and administrative expenses increase significantly subsequent to the spin-off, indicating that the spun-off unit incurs significant setup costs after it becomes detached from the parent firm. The last line in Table 3 reports a F-test between the coefficients on the dummies $ParAft$ and $SubAft$. As can be seen from the significance of the tests, the increase in efficiency following spin-offs comes only from plants associated with the parent entity, and spin-offs affect costs, sales, and capital expenditures of plants in the parent unit very differently from those in the subsidiary unit.

3.2.3 Dynamic Pattern of Productivity Changes Subsequent to a Spin-off

In this sub-section we investigate how the effect of a spin-off on a plant is dynamically distributed over time subsequent to the spin-off. To analyze this we employ the following regression framework:

$$Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \sum_{s=0}^{\geq 4} \delta_s SpinAfter_{it}^s + \varepsilon_{it} \tag{4}$$

where Y_{it} and X_{it} are as defined before, and the regression is estimated with plant fixed effects and year dummies. The dummy variable $SpinAfter_{it}^s$ equals 1 if the plant is involved in a spin-off and the observation is s years after the spin-off, where $s = 0, 1, 2, 3,$and 4 and above.[22] The dynamic pattern of the effect on the variables of interest are captured by the coefficients δ^s.

The results are presented in Table 4. The increase in TFP (efficiency) of the spin-off plants starts from one year after the spin-off and continues for four years and after. In all the years the coefficient on the dummy in the TFP regression is significant at the 1% level. The dynamic patterns of the effects on the channels through which this efficiency arises are as follows. Total employment goes down in the year of the spin-off (significant at 10%), and again in year 2 (significant at 10%), year 3, and years 4 and above, significant in both cases at the 1% level. Total wages start going down from year 2 (significant at 5%) onwards. Materials cost goes down immediately in the year of the spin-off, and then again in year 4 and above. As before, product market performance (sales) do not change in any year following the spin-off. From this dynamic pattern we see that in the year of the spin-off new capital expenditures increase significantly, but however in the following year they go down significantly, back to their original level.

Overall, the results show us that the increase in efficiency of a plant involved in a spin-off is immediate and permanent, i.e., TFP increases in the year immediately following the spin-off and remains at that level for every year after that. The decrease in total wages however affects the labor market negatively only after two years subsequent to the spin-off.

[22] For example, $SpinAfter_{it}^0$ refers to a spin-off plant in the year of the spin-off and $SpinAfter_{it}^1$ refers to a spin-off plant one year after the spin-off, and so on.

3.2.4 Differences Between Parent and Subsidiary Plants Before and After the Spin-off

To investigate how parent and subsidiary plants involved in spin-offs, differ from one another over time around the spin-off, we estimate the following regressions:

$$Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \sum_{s=-1}^{\leq -3} \delta_s SubBef_{it}^s + \varepsilon_{it} \tag{5}$$

$$Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \sum_{s=0}^{\geq 4} \delta_s SubAft_{it}^s + \varepsilon_{it} \tag{6}$$

where $SubBef_{it}^s$ is a dummy variable equal to 1 if it is a subsidiary plant and the observation is s years before the spin-off, where $s = 0, 1, 2,$ and 3 and above, and 0 otherwise. Similarly, $SubAft_{it}^s$ is a dummy variable equal to 1 if it is a subsidiary plant and the observation is s years after the spin-off, where $s = 0, 1, 2, 3,$and 4 and above, and 0 otherwise. Y_{it} and X_{it} are as defined before. The regression is estimated only on the sample of spin-off plants, i.e., on plants belonging to both the parent unit and the subsidiary unit, with year dummies. The difference between the plants in the two units are captured by the $\delta' s$, the coefficients on the dummies. Each coefficient represents how the plants in the two units differ from each other in the years around the spin-off.

Panel A of Table 5 reports the differences between the plants belonging to the two units (parent and subsidiary) before the spin-off. We report the differences one year prior to the spin-off, two years prior to the spin-off, and three years or more prior to the spin-off. The results of Panel A is one of the major findings of this paper. Contrary to the speculation in the existing spin-off literature, the results show that plants belonging to the subsidiary or spun-off entity do not underperform the parent plants prior to the spin-off. In fact, in the year immediately before the spin-off these plants outperform the parent plants; their TFP is significantly higher than that of the parent plants. Moreover, also in the years before that TFP of the spun-off plants are similar to that of the parent plants. This result, therefore, disproves the notion that firms spin-off underperforming units.[23]

The post spin-off comparison between parent and subsidiary plants are reported in Panel B of Table 5. The results show that plants belonging to the spun-off entity perform significantly worse after the spin-off.

[23] Based on the performance of the spun-off entity after the spin-off, the existing literature has speculated that firms spin-off underperforming divisions. However, in all prior studies this hypothesis has not been tested directly as it was not possible to separate the operating performance of the two entities prior to the spin-off. In this study, since we use plant level data, and measure TFP of plants, we are able to observe the overall efficiency of the plants belonging to the spun-off entity both before and after the spin-off.

Immediately after the spin-off, the TFP of subsidiary plants is significantly less than that of the parent plants, and continue to be so upto two years after the spin-off. The spun-off plants do appear to recover somewhat in year three after the spin-off; in that year their TFP is not significantly different from the TFP of the parent plants.

Overall, the results from this section show that plants belonging to the spun-off entity perform worse compared to the parent plants after the spin-off. However, contrary to the previous literature, we show that they do not underperform the parent plants prior to the spin-off; infact immediately preceding the spin-off they have significantly higher TFP compared to the parent plants.

3.3 Effect of Spin-off on Plants Subsequently Acquired or not Acquired

In this sub-section, we present evidence regarding the mechanism through which value improvements may occur after spin-offs. The disciplining theory of Chemmanur and Yan (2004) argues that spin-offs increase the probability of a takeover, and there are two possible mechanisms through which this might affect the productivity of plants involved in spin-offs, namely, the "pure disciplining effect" and the "change of control effect". We investigate how productivity of plants is affected through these two mechanisms and also the channels through which these mechanisms operate.

In order to identify these effects we conducted a split-sample analysis of plants that were subsequently acquired after spin-offs versus those that were not acquired after spin-offs. First, we identified all acquisitions in the LRD, by linking the LRD to the Ownership Change Database (OCD).[24] Since the OCD is available only till 1992, in this part of the study our sample of spin-offs is also restricted till 1992.

3.3.1 Univariate Results on Acquired versus Non-acquired Plants

Panels A and B of Table 6 present the univariate results of the effect of spin-offs on subsequently acquired and non-acquired spin-off plants respectively. In both sub-samples, TFP increases significantly after the spin-off; the increase appears to be more for the plants that were subsequently acquired. Acquired plants experience a significant drop in total employment, total wages, materials cost, and sales after the spin-off, while non-acquired plants experience a significant drop in total employment only. Furthermore, for non-acquired plants

[24] For a detailed description of the OCD and its construction see Nguyen (1998).

sales improves significantly, following the spin-off, thus indicating that the increase in TFP might be partially due to the improved product market performance of these plants after the spin-off. However, these are only univariate statistics and hence the results should be interpreted with caution.

3.3.2 The Average Effect of Spin-offs on Plants Subsequently Acquired or not Acquired

We now differentiate the spin-off plants based on whether they were acquired subsequent to the spin-off or not. To capture the effects of the spin-off we estimate a modified version of our original regression framework, for subsequently acquired non-acquired plants.

$$Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_1 Acquired_{it} + \delta_2 NonAcquired_{it} + \varepsilon_{it} \quad (7)$$

where Y_{it} is the variable of interest, (e.g., TFP, log of total wages etc.), and X_{it} is a control for plant size which is time varying. In (7) $Acquired_{it}$ is a dummy variable, which equals 1 if it is a plant that was subsequently acquired and the observation is in a year after the spin-off, and 0 if it is a non-spin-off plant or an acquired plant with the observation belonging to a year prior to the spin-off. Similarly, $NonAcquired_{it}$ is a dummy variable, which equals 1 if it is a plant that was not acquired after the spin-off and the observation is in a year after the spin-off, and 0 if it is a non-spin-off plant or a non-acquired plant with the observation belonging to a year prior to the spin-off.[25] The regression is estimated with plant fixed effects and year dummies. The results are presented in Table 7.

As before, the coefficient of interest is δ_1 and δ_2. As can be seen from the results, TFP increases significantly after a spin-off for both acquired and non-acquired plants. The magnitude of the increase appears to be slightly larger for the acquired plants, however the difference is not statistically significant. Moreover, it can be seen from the results that the channels through which the increase in overall efficiency arises differs between the subsequently acquired plants and the non-acquired plants. For the acquired sample we observe a decrease in materials costs, but an increase in rental and administrative expenses (both significant at the 1% level). For the non-acquired sample the increase in efficiency primarily comes through a significant reduction in employment and total wages (both are significant at the 1% level), and also due to reductions in rental and administrative

[25] In the results presented here we define a plant as acquired if the acquisition took place within five years of the spin-off. However, in results not reported here, we also estimate the regression by defining acquired as those acquisitions within three years and those within seven years from the spin-off year. The results remain qualitatively the same in both cases.

expenses. The last line in Table 7 reports a F-test between the coefficients on the dummies *Acquired* and *Nonacquired*. Even though the overall increase in efficiency is not significantly different between the two samples, it is clear from the significance of the t-tests that the channels through which spin-offs affect the increase in efficiency of acquired plants and non-acquired plants is very different. These results provide us with some clue regarding the mechanism by which spin-offs operate. It appears that while the "change of control" effect predominantly affects the acquired plants, the "pure disciplining effect" affects the non-acquired plants. We investigate this issue in more detail in the following sub-section.

3.3.3 The Dynamic Effect of Spin-offs on Plants Subsequently Acquired or not Acquired

In this section we attempt to separate the "pure disciplining effect" from the "change of control" effect. We do this by dynamically splitting up both the acquired and the non-acquired sample of spin-off plants. For the acquired sample, we split up the effect of the spin-off into one that appears after the spin-off but before the acquisition, and the second that appears after the acquisition.[26] We implement this approach within the following regression framework.

$$Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_1 Between_{it} + \delta_2 After_{it} + \varepsilon_{it} \tag{8}$$

where Y_{it} is the variable of interest, (e.g., TFP, log of total wages etc.), and X_{it} is a control for plant size which is time varying. In (8) $Between_{it}$ is a dummy variable, which equals 1 if it is a spin-off plant that was subsequently acquired and the observation is in a year after the spin-off but before the acquisition, and 0 otherwise. On the other hand, $After_{it}$ is a dummy variable, which equals 1 if it is a spin-off plant that was subsequently acquired and the observation is in a year after the acquisition, and 0 otherwise. The regression is estimated with plant fixed effects and year dummies. The coefficients δ_1 and δ_2 capture the "pure disciplining effect" and the "change of control" effect respectively.

The results presented in Table 8 show that for plants which were acquired subsequent to the spin-off, the improvement in efficiency is entirely due to the "change of control" effect, i.e., efficiency increases only after the plants are acquired by a management team with superior ability. Again, the channels through which efficiency

[26] The intuition is that the effect which appears after the spin-off but before the acquisition would be due to the "pure disciplining effect" i.e., incumbent management working harder in order to retain control, while the effect that appears after the acquisition would be due to the "change of control" effect, i.e., efficiencies arising due to a management team with superior abilities.

improves after the acquisition are due to decreases in total wages (significant at 5%), employment (significant at 1%), and materials costs (significant at 1%). The last line on Table 8 reports the F-test between the coefficients $Between$ and $After$, which shows that the effect on TFP of spin-off and acquisition, on subsequently acquired plants, is significantly different from each other.

In the case of the non-acquired sample, we dynamically split up the effect of the spin-off as before. To implement this we employ the same dynamic regression framework:

$$Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \sum_{s=0}^{\geq 4} \delta_s NonAcqAfter_{it}^s + \varepsilon_{it} \tag{9}$$

where Y_{it} and X_{it} are as defined before, and the regression is estimated with plant fixed effects and year dummies. The dummy variable $NonAcqAfter_{it}^s$ equals 1 if it is a non-acquired spin-off plant and the observation is s years after the spin-off, where $s = 0, 1, 2, 3$,and 4 and above. The dynamic pattern of the effect on the variables of interest are captured by the coefficients δ^s.

The results presented in Table 9 provides evidence for the "pure disciplining effect". In the year immediately following the spin-off TFP (efficiency) increases significantly and remains there for upto three years after the spin-off. All the coefficients are significant at the 1% level. This provides evidence supporting the notion that the incumbent management works harder following the spin-off so as to improve efficiency in order to retain control over the assets under its management. Also, consistent with the disciplining theory this increase in TFP is achieved by cutting back on costs associated with the production process. Total employment, total wages, materials cost, and rental and administrative expenses all decrease significantly immediately after the spin-off, the coefficients being significant at the 1% level. With the exception of materials cost all the other variables are significantly negative (at the 1% level) in every year after that for the next four years. Again, the increase in TFP for these plants does not at all come from better product market performance. In fact, for these plants sales drops significantly after the spin-off. Moreover, it also does not appear that new capital expenditure leads to the increase in TFP. While it is significantly positive in the year of the spin-off, it drops down the very next year to its pre-spin-off level, and does not change in the years after that. Since these plants are the ones that were not acquired after the spin-off, the only mechanism through which spin-offs can affect efficiency in these plants is through the "pure disciplining effect".

In the results presented in Table 8 and Table 9, we provide evidence separating out the "pure disciplining effect" from the "change of control" effect. While both mechanism are responsible for the overall increase in TFP associated with spin-off plants that we documented at the beginning, their impact is dynamically separated over time and hence they affect different sub-samples of spin-off plants. While, the "pure disciplining effect" kicks in right after the spin-off, the "change of control" effect kicks in only if the spin-off plant is acquired subsequently. Thus, the improvement in TFP in the non-acquired sample of plants comes from the "pure disciplining effect", while the improvement in TFP for the acquired plants comes from the "change of control" effect. The result of the two samples therefore suggest that plants which do not experience an improvement in their productivity immediately following the spin-off due to the disciplining of management, ultimately end up getting acquired by a management team with superior abilities and then experience an increase in productivity.

3.4 Effect of Spin-offs on Plants in Related and Unrelated Spin-offs

Finally, we investigate if there is a difference in the effect of spin-offs between plants in related industries and those which belong to unrelated industries. We define a plant as being involved in a related spin-off if it operates in the same 2-digit SIC industry after the spin-off, as defined by the main industry affiliation of the firm to which it belongs; and we define a plant as being involved in an unrelated spin-off if it operates in a different 2-digit SIC industry after the spin-off, than the main industry affiliation of the firm to which it belongs.[27] Panels A and B of Table 10 presents the univariate results of the effect of spin-offs on related and unrelated spin-off plants respectively. Firstly, we show that both related and unrelated plants experience an increase in their TFP after the spin-off, and it appears that the magnitude of the increase is greater for unrelated plants. For related plants, the increase in TFP arises primarily due to decreases in employment, labor wages, materials costs, and rental and administrative expenses. For unrelated plants, it appears that the increase in TFP primarily comes due to better product market performance, i.e., increase in sales after the spin-off. However, these results should merely be treated as indicative as we do not appropriately control for other confounding effects.

In order to control for such confounding effects and analyze the effects of spin-offs on related and unrelated plants, we employ the following regression framework:

[27] For example, if a plant operates in SIC 2530, and the main SIC industry of the firm to which it belongs is 2500, then we categorize it as a related spin-off. On the other hand, if the plant operates in SIC 2850, we define it as an unrelated spin-off.

$$Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_1 Related_{it} + \delta_2 Unrelated_{it} + \varepsilon_{it} \quad (10)$$

where Y_{it} and X_{it} are as defined before. In (10) $Related_{it}$ is a dummy variable, which equals 1 if it is a related spin-off plant and the observation is in a year after the spin-off, and 0 if it is a non-spin-off plant or a related plant with the observation belonging to a year prior to the spin-off. Similarly, $Unrelated_{it}$ is a dummy variable, which equals 1 if it is an unrelated spin-off plant and the observation is in a year after the spin-off, and 0 if it is a non-spin-off plant or an unrelated plant with the observation belonging to a year prior to the spin-off. The regression is estimated with plant fixed effects and year dummies. The results are presented in Table 11.

Overall the results show that plants belonging to both related and unrelated spin-offs show an improvement in TFP subsequent to the spin-off, and the difference between this increase is statistically insignificant between the two.[28] For unrelated spin-offs the channels of value improvement appears to be decreases in labor market costs and other administrative expenses, while for related spin-offs the increase in efficiency partially comes from decrease in materials costs, and partially from new capital expenditures. Also from the F-tests between the coefficients of *Related* and *Unrelated* it appears that the disciplining effect has a stronger impact for unrelated spin-off plants.

4 Conclusion

Using a unique sample of plant level data from the Longitudinal Research Database (LRD), we identify (for the first time in the literature), how (the precise channel and mechanism), where (parent or subsidiary), and when (the dynamic pattern) performance improvements arise following corporate spin-offs. We identify the source of value improvements in spin-offs by comparing the magnitude of post-spin-off changes in the wages, employment, materials costs, rental and administrative expenses, sales, and capital expenditures in the plants belonging to firms undergoing spin-offs relative to the magnitude of such changes in a control group of plants belonging to firms not undergoing spin-offs. We show that the total factor productivity (TFP) of plants belonging

[28] This result of ours are at odds with those of Daley, Mehrotra, and Sivakumar (1997) and Desai and Jain (1999), who argue that the entire improvement in operating performance of firms subsequent to a spin-off comes from unrelated spin-offs only. We show that both related and unrelated spin-off plants show an increase in efficiency after the spin-off. One important caveat is that the LRD only contains information for plants in the manufacturing sector, thus if a spin-off firm has non-manufacturing plants, they will not be surveyed in the LRD. However, even when we restrict out sample to those unrelated spin-offs which are only within the manufacturing sector, we still find the same results and with similar levels of significance. Thus our results are robust, at least within the manufacturing sector.

to spin-off firms (parent or spun-off subsidiary) increase, on average, following the spin-off. This increase in TFP translates to an increase in profits for the plants of approximately 8% annually. This increase in overall productivity begins immediately, starting with the first year following the spin-off, and continuing in the years thereafter. This performance improvement can be attributed to a decrease in workers' wages, employment at the plant, decrease in the cost of materials purchased, as well as a decrease in rental and office expenditures, but not from improved product market performance by these plants. Total wages in spin-off plants go down by about 2.5% following spin-offs, which translates to a decrease of approximately $10.2 million annually for an average firm involved in a spin-off. Further, such productivity improvements arise primarily in plants that remain with the parent; plants belonging to the spun-off subsidiary do not experience such productivity increases. However, contrary to speculation in the previous literature, plants that are spun-off do not underperform parent plants prior to the spin-off. Finally, in our split-sample study of plants that were acquired subsequent to the spin-off and those that were not, we find that productivity increases for both groups of plants: while such productivity increases start immediately after the spin-off for the non-acquired plants, for the acquired plants they occur only after being taken over by a better management team.

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Table 1

This table presents univariate tests showing the real effects of spin-offs on plants belonging to firms which had a spin-off. Total factor productivity (*TFP*) at the four digit SIC level, is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The results of *t*-tests for difference in means and the Wilcoxon rank sum test (*z*-statistic) for the difference in distribution of the variables are reported. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

Spin-off Plants Before and After Spin-off

	Number of Observations	Mean	Standard Deviation	Difference in Means (*t*-test)	Wilcoxon rank sum test (*z*-statistic)
TFP:					
Before	15632	0.023	0.279		
After	12503	0.035	0.291	0.012***	4.13***
Total Employment:					
Before	16548	5.023	1.430		
After	14902	4.953	1.435	-0.070***	-4.46***
Total Wage:					
Before	16258	8.394	1.504		
After	14720	8.350	1.513	-0.043**	-2.20**
Sales:					
Before	16372	10.029	1.539		
After	14623	10.041	1.539	0.013	1.49
Materials Cost:					
Before	16191	9.244	1.608		
After	14197	9.326	1.653	0.083***	5.94***
Rental and Administrative Expenses:					
Before	9160	6.812	1.465		
After	5521	6.783	1.414	-0.029	-1.81*
New Capital Expenditure:					
Before	14857	6.299	1.882		
After	13684	6.309	1.828	0.010	0.52

Table 2

This table shows the real effects of spin-offs on plants belonging to firms which had a spin-off. The first column shows the effect on overall plant productivity and the remaining columns analyze how this effect on productivity can be dismantled. The dependent variables of the different specifications are total factor productivity (*TFP*) at the four digit SIC level, total employment, total wages, sales, materials cost, rental and administrative expenses, and new capital expenditure. *TFP* is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The following panel regression is estimated in all the specifications: $Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta SpinAft + \varepsilon_{it}$, where Y_{it} is the dependent variable (such as *TFP*) of interest, X_{it} is plant size which is measured as the log of total assets (building + machinery), *SpinAft* is a dummy variable and equals 1 if the plant belongs to a spin-off firm and the observation is in a year after the spin-off. The effect of spin-offs on plants is captured by the coefficient δ. Heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

	Total Factor Productivity	Total Employment	Total Wage	Sales	Materials Cost	Rental and Administrative Expenses	New Capital Expenditure
SpinAft	0.013***	-0.025***	-0.024***	-0.008	-0.019***	0.008	-0.008
	(0.002)	(0.004)	(0.004)	(0.006)	(0.006)	(0.009)	(0.012)
Size	-0.031***	0.405***	0.454***	0.466***	0.489***	0.435***	1.084***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.005)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.416	0.919	0.923	0.897	0.879	0.888	0.684
Sample Size	854908	881310	882408	881573	879506	667450	781608

Table 3

This table shows the real effects of spin-offs separately on plants belonging to the parent unit of firms which had a spin-off, and on plants belonging to the subsidiary or spun-off unit. The first column shows the effect on overall plant productivity and the remaining columns analyze how this effect on productivity can be dismantled. The dependent variables of the different specifications are total factor productivity (*TFP*) at the four digit SIC level, total employment, total wages, sales, materials cost, rental and administrative expenses, and new capital expenditure. *TFP* is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The following panel regression is estimated:
$Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_1 ParAft + \delta_2 SubAft + \varepsilon_{it}$, where Y_{it} is the dependent variable (such as *TFP*) of interest, X_{it} is plant size which is measured as the log of total assets (building + machinery). The dummy variable *ParAft* equals 1 if the plant belongs to the parent unit and in an year after the spin-off, and the dummy *SubAft* equals 1 if the plant belongs to the spun-off unit and in an year after the spin-off. The effect of spin-offs on plants is captured by the coefficient δ's. The last row reports *F*-tests on the difference between the δ coefficients. Heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

	Total Factor Productivity	Total Employment	Total Wage	Sales	Materials Cost	Rental and Administrative Expenses	New Capital Expenditure
ParAft	0.016***	-0.034***	-0.027***	-0.003	-0.007	-0.024**	-0.015
	(0.003)	(0.005)	(0.006)	(0.007)	(0.008)	(0.012)	(0.014)
SubAft	0.006	-0.007	-0.017**	-0.017*	-0.044***	0.072***	0.006
	(0.004)	(0.007)	(0.007)	(0.009)	(0.010)	(0.016)	(0.020)
Size	-0.031***	0.405***	0.454***	0.466***	0.489***	0.435***	1.083***
	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
Adjusted R^2	0.416	0.919	0.923	0.897	0.879	0.888	0.683
Sample Size	854908	881310	882408	881537	879506	667450	781608
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test	4.33**	9.78***	1.05	1.48	8.47***	23.82***	0.73

Table 4

This table presents the dynamic distribution of the real effects of spin-offs on plants belonging to firms which had a spin-off. The first column shows the effect on overall plant productivity and the remaining columns analyze how this effect on productivity can be dismantled. The dependent variables of the different specifications are total factor productivity (*TFP*) at the four digit SIC level, total employment, total wages, sales, materials cost, rental and administrative expenses, and new capital expenditure. *TFP* is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The following panel regression is estimated in all the different specifications: $Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_0 SpinAfter^0 + \delta_1 SpinAfter^1 + \delta_2 SpinAfter^2 + \delta_3 SpinAfter^3 + \delta_4 SpinAfter^{+4} + \varepsilon_{it}$, where Y_{it} is the dependent variable (such as *TFP*) of interest, X_{it} is plant size which is measured as the log of total assets (building + machinery), $SpinAfter^0$ is a dummy variable which takes the value of 1 for the spin-off year if the plant belongs to a spin-off firm, $SpinAfter^1$ equals 1 for one year after the spin-off for a spin-off plant, and similarly for $SpinAfter^2$, $SpinAfter^3$ and $SpinAfter^{+4}$ which equals 1 for four years and more after the spin-off for a spin-off plant. Heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

	Total Factor Productivity	Total Employment	Total Wage	Sales	Materials Cost	Rental and Administrative Expenses	New Capital Expenditure
$SpinAfter^0$	0.005	-0.013*	-0.003	-0.014	-0.022*	0.011	0.046**
	(0.004)	(0.008)	(0.008)	(0.010)	(0.011)	(0.017)	(0.021)
$SpinAfter^1$	0.013***	0.000	0.002	0.006	-0.001	0.014	-0.056**
	(0.005)	(0.008)	(0.008)	(0.011)	(0.011)	(0.017)	(0.022)
$SpinAfter^2$	0.017***	-0.015*	-0.020**	-0.001	-0.023*	0.004	0.029
	(0.005)	(0.008)	(0.009)	(0.011)	(0.013)	(0.019)	(0.025)
$SpinAfter^3$	0.018***	-0.025***	-0.018*	0.003	-0.018	-0.015	-0.002
	(0.005)	(0.009)	(0.009)	(0.011)	(0.014)	(0.020)	(0.026)
$SpinAfter^{>=4}$	0.014***	-0.049***	-0.052***	-0.017**	-0.026***	0.013	-0.031*
	(0.004)	(0.002)	(0.007)	(0.008)	(0.010)	(0.015)	(0.017)
Size	-0.031***	0.405***	0.454***	0.466***	0.489***	0.435***	1.083***
	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.416	0.919	0.923	0.897	0.879	0.888	0.684
Sample Size	854908	881310	882408	881537	879506	667450	781608

Table 5

This table presents the dynamic differences between parent and subsidiary plants before and after spin-offs. The dependent variables are the column headings as before. The following panel regressions are estimated on the sample in Panel A and Panel B respectively: $Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_{-3} SubBef^{-3} + \delta_{-2} SubBef^{2} + \delta_{-1} SubBef^{1} + \varepsilon_{it}$ and $Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_0 SubAft^0 + \delta_1 SubAft^1 + \delta_2 SubAft^2 + \delta_3 SubAft^3 + \delta_4 SubAft^4 + \varepsilon_{it}$, where Y_{it} is the dependent variable (such as *TFP*) of interest, X_{it} is plant size which is measured as the log of total assets (building + machinery), $SubBef^{-3}$ is a dummy variable that takes the value of 1 for a plant belonging to a subsidiary three years or more before the spin-off, $SubBef^{2}$ is a dummy variable that takes the value of 1 for a subsidiary plant two years before the spin-off, $SubBef^{1}$ is a dummy variable that takes the value of 1 for a subsidiary plant one year before the spin-off. The $SubAft^{t}$ dummies are defined similarly as having the value of 1 for a subsidiary plant *t* years after the spin-off year. Heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

Panel A: Differences between Parent and Subsidiary plants before the spin-off

	Total Factor Productivity	Total Employment	Total Wage	Sales	Materials Cost	Rental and Administrative Expenses	New Capital Expenditure
$SubBef^{<-3}$	0.001	0.314***	0.167***	0.135***	0.164***	0.151***	-0.054***
	(0.003)	(0.011)	(0.010)	(0.009)	(0.012)	(0.011)	(0.015)
$SubBef^{2}$	0.016	0.056*	0.016	0.045	0.069**	0.112***	0.137***
	(0.010)	(0.033)	(0.030)	(0.028)	(0.031)	(0.037)	(0.043)
$SubBef^{1}$	0.025**	0.020	0.000	0.056*	0.046	0.130***	0.106**
	(0.010)	(0.034)	(0.032)	(0.029)	(0.036)	(0.043)	(0.043)
Size	0.001	0.644***	0.752***	0.764***	0.761***	0.752***	0.975***
	(0.001)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Adjusted R^2	0.040	0.560	0.641	0.683	0.601	0.612	0.620
Sample Size	58086	57214	57032	57835	57115	48404	53480

Panel B: Differences between Parent and Subsidiary plants after the spin-off

	Total Factor Productivity	Total Employment	Total Wage	Sales	Materials Cost	Rental and Administrative Expenses	New Capital Expenditure
$SubAft^{0}$	-0.020**	0.034	-0.016	-0.060**	-0.133***	-0.083**	-0.068
	(0.010)	(0.032)	(0.030)	(0.030)	(0.037)	(0.042)	(0.042)
$SubAft^{1}$	-0.033***	0.035	-0.022	-0.069**	-0.088**	0.055	-0.197***
	(0.011)	(0.035)	(0.034)	(0.035)	(0.039)	(0.061)	(0.047)
$SubAft^{2}$	-0.039***	-0.002	-0.060	-0.032	-0.061	0.126***	-0.091*
	(0.013)	(0.041)	(0.037)	(0.036)	(0.044)	(0.046)	(0.049)
$SubAft^{3}$	-0.020	-0.011	-0.061	-0.021	-0.089**	-0.105*	-0.154***
	(0.013)	(0.041)	(0.037)	(0.035)	(0.043)	(0.064)	(0.048)
$SubAft^{>=4}$	-0.011*	0.018	-0.037*	0.044**	-0.045*	-0.034	-0.084***
	(0.007)	(0.021)	(0.020)	(0.018)	(0.023)	(0.035)	(0.025)
Size	0.003**	0.654***	0.750***	0.777***	0.805***	0.744***	0.942***
	(0.001)	(0.005)	(0.006)	(0.005)	(0.006)	(0.009)	(0.006)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant fixed effects	No	No	No	No	No	No	No
Adjusted R^2	0.030	0.573	0.651	0.673	0.604	0.645	0.603
Sample Size	17504	17886	17612	17541	17413	6224	16536

Table 6

This table presents univariate tests showing the real effects of spin-offs on plants that were subsequently acquired after the spin-off. Total factor productivity (*TFP*) at the four digit SIC level, is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The results of *t*-tests for difference in means and the Wilcoxon rank sum test (*z*-statistic) for the difference in distribution of the variables are reported. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

Panel A: Subsequently Acquired Spin-off Plants Before and After Spin-off

	Number of Observations	Mean	Standard Deviation	Difference in Means (*t*-test)	Wilcoxon rank sum test (*z*-statistic)
TFP:					
Before	2109	0.013	0.272		
After	2022	0.030	0.316	0.017*	2.18**
Total Employment:					
Before	2165	4.891	1.641		
After	2104	4.749	1.648	-0.142***	-3.20***
Total Wage:					
Before	2186	8.285	1.636		
After	2117	8.181	1.704	-0.105**	-1.85*
Sales:					
Before	2158	9.907	1.581		
After	2092	9.800	1.634	-0.107**	-2.18**
Materials Cost:					
Before	2108	8.993	1.698		
After	2037	8.880	1.858	-0.113**	-1.55
Rental and Administrative Expenses:					
Before	2049	6.722	1.587		
After	1445	6.746	1.401	0.024	-1.08
New Capital Expenditure:					
Before	2030	5.985	1.881		
After	1936	5.924	1.913	-0.061	-0.63

Table 6 (cont'd)

This table presents univariate tests showing the real effects of spin-offs on plants that were not subsequently acquired after the spin-off. Total factor productivity (*TFP*) at the four digit SIC level, is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The results of *t*-tests for difference in means and the Wilcoxon rank sum test (*z*-statistic) for the difference in distribution of the variables are reported. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

Panel B: Non-acquired Spin-off Plants Before and After Spin-off

	Number of Observations	Mean	Standard Deviation	Difference in Means (*t*-test)	Wilcoxon rank sum test (*z*-statistic)
TFP:					
Before	13260	0.024	0.280		
After	10069	0.034	0.288	0.011***	3.34***
Total Employment:					
Before	14113	5.044	1.401		
After	12365	4.988	1.402	-0.055***	-3.30***
Total Wage:					
Before	13802	8.412	1.489		
After	12170	8.382	1.488	-0.029	-1.34
Sales:					
Before	13944	10.047	1.541		
After	12098	10.080	1.535	0.033*	2.54**
Materials Cost:					
Before	13814	9.283	1.596		
After	11728	9.402	1.619	0.119***	7.12***
Rental and Administrative Expenses:					
Before	6847	6.843	1.438		
After	3663	6.799	1.447	-0.044	-1.16
New Capital Expenditure:					
Before	12571	6.353	1.885		
After	11332	6.384	1.817	0.030	1.21

Table 7

This table shows the real effects of spin-offs on plants that were subsequently acquired after the spin-off, and on plants that were not acquired after the spin-off. The dependent variables are as before and shown below in the column headings. *TFP* is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The following panel regression is estimated in all the specifications: $Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_1 Acquired + \delta_2 Non-acquired + \varepsilon_{it}$, where Y_{it} is the dependent variable (such as *TFP*) of interest, X_{it} is plant size which is measured as the log of total assets (building + machinery). The dummy variable *Acquired* equals 1 if the plant was acquired subsequent to spin-off and belongs to an year after the spin-off, and the dummy *Non-acquired* equals 1 if the plant was not acquired subsequent to spin-off and belongs to an year after the spin-off. The effect of spin-offs on plants is captured by the coefficient δ_1 and δ_2. The last row reports *F*-tests on the difference between the coefficients δ_1 and δ_2. Heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

	Total Factor Productivity	Total Employment	Total Wage	Sales	Materials Cost	Rental and Administrative Expenses	New Capital Expenditure
Acquired	0.019**	-0.004	0.005	0.018	-0.060***	0.073***	0.026
	(0.006)	(0.010)	(0.011)	(0.012)	(0.014)	(0.016)	(0.028)
Non-Acquired	0.012***	-0.029***	-0.030***	-0.014**	-0.008	-0.023*	-0.016
	(0.003)	(0.005)	(0.005)	(0.006)	(0.007)	(0.012)	(0.013)
Size	-0.031***	0.405***	0.454***	0.466***	0.489***	0.434***	1.083***
	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
Adjusted R^2	0.416	0.920	0.923	0.897	0.879	0.888	0.684
Sample Size	853908	880276	881380	880501	878473	666536	780617
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test	1.35	4.72**	7.96***	5.29**	10.52***	22.85***	1.86

Table 8

This table splits the disciplining effect of spin-offs into the pure disciplining effect and the change of control effect. The dependent variables are as before and shown below in the column headings. *TFP* is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The following panel regression is estimated in all the specifications: $Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_1 Between + \delta_2 After + \varepsilon_{it}$, where Y_{it} is the dependent variable (such as *TFP*) of interest, X_{it} is plant size which is measured as the log of total assets (building + machinery). The dummy variable *Between* equals 1 for the subsequently acquired plant, after the spin-off but before the acquisition, and the dummy *After* equals 1 for the subsequently acquired plant after the acquisition. The pure disciplining effect on subsequently acquired spin-off plants is captured by the coefficient δ_1, while the change of control effect on subsequently acquired spin-off plants is captured by the coefficient δ_2. The last row reports *F*-tests on the difference between the coefficients δ_1 and δ_2. Heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

	Total Factor Productivity	Total Employment	Total Wage	Sales	Materials Cost	Rental and Administrative Expenses	New Capital Expenditure
Between	0.009	0.050***	0.059***	0.036**	0.002	0.092***	0.066*
	(0.008)	(0.013)	(0.013)	(0.016)	(0.020)	(0.020)	(0.039)
After	0.026***	-0.042***	-0.034**	0.013	-0.099***	0.063**	0.025
	(0.007)	(0.014)	(0.015)	(0.017)	(0.019)	(0.025)	(0.038)
Size	-0.033***	0.401***	0.449***	0.460***	0.482***	0.431***	1.081***
	(0.001)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)
Adjusted R^2	0.420	0.920	0.924	0.898	0.880	0.887	0.679
Sample Size	786696	813761	815381	813684	812351	618673	718687
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test	2.81*	28.64***	25.89***	1.20	15.01***	0.92	0.66

Table 9

This table presents the dynamic distribution of the real effects of spin-offs on plants belonging to firms which had a spin-off, but which were not acquired subsequent to the spin-off. The dependent variables of the different specifications are total factor productivity (*TFP*) at the four digit SIC level, total employment, total wages, sales, materials cost, rental and administrative expenses, and new capital expenditure. *TFP* is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The following panel regression is estimated in all the different specifications:
$Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_0 DumAfter^0 + \delta_1 DumAfter^1 + \delta_2 DumAfter^2 + \delta_3 DumAfter^3 + \delta_4 DumAfter^{+4} + \varepsilon_{it}$, where Y_{it} is the dependent variable (such as *TFP*) of interest, X_{it} is plant size which is measured as the log of total assets (building + machinery). The variable $DumAfter^t$ is a dummy variable which equals 1 if the plant wasn't acquired subsequent to the spin-off and belongs to the year *t* after the spin-off, where *t=0, 1, 2, 3, and 4*. Heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

	Total Factor Productivity	Total Employment	Total Wage	Sales	Materials Cost	Rental and Administrative Expenses	New Capital Expenditure
$DumAfter^0$	0.006	-0.041***	-0.034***	-0.046***	-0.036***	-0.060***	0.049**
	(0.005)	(0.008)	(0.008)	(0.011)	(0.012)	(0.021)	(0.023)
$DumAfter^1$	0.017***	-0.032***	-0.031***	-0.024*	-0.013	-0.062***	-0.074***
	(0.005)	(0.008)	(0.009)	(0.012)	(0.012)	(0.021)	(0.025)
$DumAfter^2$	0.018***	-0.041***	-0.051***	-0.032**	-0.034**	-0.065***	0.042
	(0.006)	(0.009)	(0.009)	(0.013)	(0.014)	(0.023)	(0.027)
$DumAfter^3$	0.020***	-0.057***	-0.054***	-0.033***	-0.033**	-0.108***	-0.001
	(0.006)	(0.010)	(0.010)	(0.013)	(0.015)	(0.026)	(0.029)
$DumAfter^{>=4}$	0.007	-0.081***	-0.091***	-0.062***	-0.019	-0.089***	-0.062***
	(0.004)	(0.008)	(0.008)	(0.010)	(0.012)	(0.020)	(0.020)
Size	-0.032***	0.406***	0.448***	0.463***	0.485***	0.437***	1.108***
	(0.001)	(0.003)	(0.004)	(0.004)	(0.004)	(0.005)	(0.007)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.452	0.932	0.936	0.912	0.893	0.904	0.717
Sample Size	486586	502991	503506	503262	502646	374320	441187

Table 10

This table presents univariate tests showing the real effects of spin-offs on plants that were involved in a related spin-off. Total factor productivity (*TFP*) at the four digit SIC level, is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The results of *t*-tests for difference in means and the Wilcoxon rank sum test (*z*-statistic) for the difference in distribution of the variables are reported. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

Panel A: Spin-off Plants in Related Industries Before and After Spin-off

	Number of Observations	Mean	Standard Deviation	Difference in Means (*t*-test)	Wilcoxon rank sum test (*z*-statistic)
TFP:					
Before	4768	0.006	0.264		
After	4731	0.013	0.288	0.007	1.77*
Total Employment:					
Before	5147	5.005	1.320		
After	5667	4.697	1.614	-0.308***	-7.99***
Total Wage:					
Before	5134	8.443	1.415		
After	5638	8.141	1.744	-0.302***	-6.75***
Sales:					
Before	5072	10.157	1.406		
After	5562	9.963	1.660	-0.194***	-3.55***
Materials Cost:					
Before	5073	9.507	1.468		
After	5478	9.334	1.824	-0.173***	-1.84*
Rental and Administrative Expenses:					
Before	2454	6.952	1.415		
After	2267	6.786	1.549	-0.166***	-2.84***
New Capital Expenditure:					
Before	4641	6.300	1.838		
After	5042	6.273	1.899	-0.027	0.327

Table 10 (cont'd)

This table presents univariate tests showing the real effects of spin-offs on plants that were involved in an unrelated spin-off. Total factor productivity (*TFP*) at the four digit SIC level, is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The results of *t*-tests for difference in means and the Wilcoxon rank sum test (*z*-statistic) for the difference in distribution of the variables are reported. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

Panel B: Spin-off Plants in Unrelated Industries Before and After Spin-off

	Number of Observations	Mean	Standard Deviation	Difference in Means (*t*-test)	Wilcoxon rank sum test (*z*-statistic)
TFP:					
Before	10864	0.031	0.284		
After	7772	0.048	0.291	0.018***	4.60***
Total Employment:					
Before	11401	5.030	1.477		
After	9235	5.110	1.287	0079***	1.03
Total Wage:					
Before	11124	8.371	1.542		
After	9082	8.481	1.334	0.109***	2.60***
Sales:					
Before	11300	9.971	1.592		
After	9061	10.089	1.458	0.118***	4.28***
Materials Cost:					
Before	11118	9.124	1.654		
After	8719	9.322	1.536	0.198***	7.95***
Rental and Administrative Expenses:					
Before	6706	6.761	1.480		
After	3254	6.781	1.312	0.020	-1.05
New Capital Expenditure:					
Before	10216	6.298	1.902		
After	8642	6.330	1.785	0.032	0.48

Table 11

This table shows the real effects of spin-offs on plants in a related spin-off, and on plants which were in an unrelated spin-off. A spin-off is categorized as related if both the parent and the spun-off unit operate in the same two digit SIC industry after the spin-off, otherwise it is categorized as unrelated. The dependent variables of the different specifications are total factor productivity (*TFP*) at the four digit SIC level, total employment, total wages, sales, materials cost, rental and administrative expenses, and new capital expenditure. *TFP* is the residual from estimating a log linear Cobb-Douglas production function for each industry and year at the plant level, where one regresses the value of output (total value of shipments adjusted for changes in inventories) on labor (production worker equivalent man hours), capital stock (constructed via the perpetual inventory method), and material inputs (intermediate inputs, fuels, and energy consumed). Total employment and total wage is log of total employment and total salaries and wages of the plant, respectively. Sales is log of total value of shipments of the plant which includes inter-firm transfers valued at market prices. Materials cost, rental and administrative expenses, and new capital expenditure are all measured in logs at the individual plant level. The following panel regression is estimated in all the specifications: $Y_{it} = \alpha_t + \beta_i + \gamma X_{it} + \delta_1 R.elated + \delta_2 Unrelated + \varepsilon_{it}$, where Y_{it} is the dependent variable (such as *TFP*) of interest, X_{it} is plant size which is measured as the log of total assets (building + machinery). The dummy variable *Related* equals 1 if the plant was in a related spin-off and belongs to a year after the spin-off, and the dummy *Unrelated* equals 1 if the plant was in an unrelated spin-off and belongs to a year after the spin-off. The effect of spin-offs on plants is captured by the coefficient δ. The last row reports *F*-tests on the difference between the coefficients δ_1 and δ_2. Heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent level respectively.

	Total Factor Productivity	Total Employment	Total Wage	Sales	Materials Cost	Rental and Administrative Expenses	New Capital Expenditure
Related	0.013***	-0.011	0.005	0.012	-0.043***	0.059***	0.113***
	(0.004)	(0.007)	(0.007)	(0.009)	(0.010)	(0.014)	(0.020)
Unrelated	0.012***	-0.034***	-0.042***	-0.020***	-0.005	-0.028**	-0.079***
	(0.003)	(0.005)	(0.006)	(0.007)	(0.008)	(0.012)	(0.014)
Size	-0.031***	0.405***	0.454***	0.466***	0.489***	0.435***	1.084***
	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
Adjusted R^2	0.416	0.919	0.923	0.897	0.879	0.888	0.684
Sample Size	854908	881310	882408	881537	879506	667450	781608
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-test	0.03	7.44***	27.40***	8.65***	8.60***	21.38***	63.87***